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Brain dynamics of cognitive control processes in language production: Insights from electrophysiological and neuropsychological studies

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To speak is a deliberate action, and is therefore under cognitive control mechanisms. Behavioral studies have shown that lexical selection and speech monitoring require central attentional resources that are shared across cognitive functions (e.g., Ferreira and Paschler, 2002; Oomen and Postma, 2002). Partly overlapping frontal regions associated with control mechanisms are necessary in lexical and in non-lexical response selection (e.g., Nelson et al., 2009), and in speech and other action monitoring (Christoffels et al., 2007). However, the temporal dynamics of these control processes is largely unknown due to the major problem caused by articulation-related artifacts in temporally-resoluted studies of language production. Moreover, when and how these brain regions interact with the rest of the brain is unclear. This is because brain imaging techniques providing both high-temporal resolution and reliable spatial information are scarce in the study of the human brain.

In this talk, I will present data employing scalp EEG and behavioral measures in healthy speakers and in patients with focal left or right frontal lesions. Articulation-related artifacts were greatly reduced using a blind source separation algorithm based on canonical correlationanalysis. We used simple overt picture naming and directly compared cognitive control processes involved in speech production versus other actions using a task involving semantic interference and a task involving interference in non-lexical response selection.

Results obtained in healthy speakers reveal a set of fronto-medial activities reaching their maximum 300 to 200 ms before and around 50 ms after the vocal response associated to domain-general selection and monitoring mechanisms. Results obtained in brain-lesioned patients are informative in regard to the possible interactions underlying lexical selection and speech monitoring. They suggest that 1) interactions between the left frontal cortex and posterior brain regions are necessary for normal lexical selection starting 200 ms after stimulus onset, and 2)- a different network of brain regions may be involved in inner speech versus non-speech monitoring with a common node hosted in the medial frontal cortex.

All together, our results lead to reconsider the specificity of cognitive control mechanisms involved in language production. They suggest at least part of the networks underlying lexical selection and speech monitoring mechanisms are common to language and non-linguistic actions.

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